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Environmental Sanitation Problems in Alaska and Their Solution

By E. K. DAY, S.B., S.M.

Mr. Day is Senior Sanitary Engineer, Arctic Health Research Center, U. S. Public Health Service, in Anchorage, Alaska, and has been working in this location since November, 1948. His basic engineering training was at the University of Maine and he received his S.M. in Sanitary Engineering at Harvard in 1940.

After graduation, Mr. Day was employed by the W. K. Kellogg Foundation in Battle Creek, Michigan; later went to the Atlantic City Health Department and, in 1942, joined the U. S. Public Health Service.

ENVIRONMENTAL sanitation may be defined as the prevention of disease by elimination or control of environmental factors which form links in the chain of disease transmission. Although the ultimate objective of a sanitation program is always the same, the attainment of this objective may be complicated by numerous factors. This is particularly true in Alaska. The various complicating factors must be understood in order to modify generally accepted techniques to adapt them to existing conditions.

If a map of Alaska is superimposed on a map of the United States of the same scale, it would extend from coast to coast and from the Canadian to the Mexican borders. The total land area of Alaska is approximately one-fifth that of the United States. If you can imagine the population of a city the size of Springfield, Illinois (130,649); Altoona, Pennsylvania (138,934); or Macon, Georgia (134,464) scattered over this vast area, you can appreciate some of the problems involved in administering a public health program in Alaska. In addition, when you realize that temperature extremes of −75° F. and −100° F. mean monthly temperatures down to −21° F. in interior Alaska, that precipitation ranges from less than 5 inches at Barrow to more than 230 inches at Little Port Walter, that most of the vast area is inaccessible except by air, and that permanently frozen ground from a few inches to more than 1,000 feet in thickness underlies more than 60 per cent of the area, the problems assume even greater magnitude.

The lack of complete or reliable vital statistics does not permit an adequate evaluation of the importance of environmental control in Alaska in terms of disease prevention. However, the widespread occurrence of enteric infections and the high incidence of tuberculosis and other respiratory diseases, especially among the native population, would seem to indicate that the public health significance of environmental sanitation is essentially the same as in warmer climates.

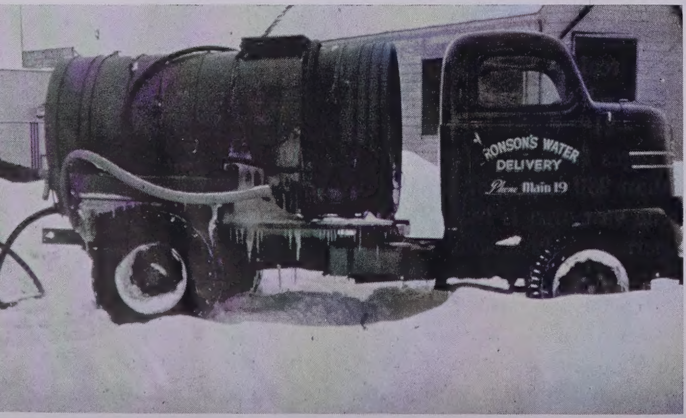
According to information from the Alaska Department of Health, 76 cases of typhoid fever and 312 cases of bacillary dysentery are known to have occurred in Alaska during the period 1937 to 1949. An additional 31 cases of typhoid fever were reported in westward Alaska during 1950 and 1951. Death rates of 540 per 100,000 for all forms of tuberculosis, and of 109 per 100,000 for pneumonia and influenza among the non-white population of Alaska in 1949, as compared with 30 and 39 per 100,000 respectively for the United States in 1948 are undoubtedly due in part to crowded living conditions.

Water Supplies

According to the best available figures, there are now 56 communities in Alaska with populations exceeding 200. Of these 56 communities, 29 have limited water distribution systems. None of these supplies is completely adequate in equipment, extent of piping and capacity of source. Wells, rivers, lakes and melted ice and snow from which water is individually obtained make up the other 27 supplies.

Adequate ground or surface water sources are generally available in the southern part of Alaska, and climatic conditions in this area are not so extreme that much, if any, deviation from conventional design and operating practices is necessary to prevent freezing difficulties. The situation, however, is very different in the areas underlain with permafrost. Even though there are numerous ponds, swamps, streams and lakes in these areas, the procurement of an adequate year around supply of water is often difficult. Shallow ground water sources (wells or springs) may dry up or freeze during the winter. Although water can be obtained from below the permafrost, drilling may be a technically difficult operation, the cost of which exceeds the financial means of most of the communities to be served. Therefore many people in the permafrost areas are dependent upon melted ice and snow as a source of water.

Water Truck — Nome, Alaska.



When ice is used as a source of water during the winter, it is cut in the fall and stored in a permafrost cellar or stacked above ground at a convenient location. Usually the ice is melted for use by placing it in a barrel or other container in the heated home. In some schools, hospitals and other government buildings special tanks equipped with steam coils are provided for melting the ice. Although ice from fresh water sources is usually available, sea ice is sometimes used. The scarcity and cost of fuel necessary for melting, added to the labor needed for cutting and transporting the ice makes this method impractical for obtaining large quantities of water.

In the low temperature areas the most common method of water distribution is on a house to house basis by tank trucks or by sledge and barrel. Occasionally limited distribution systems are in use during the summer. These are usually above ground and are dismantled during the 8 to 9 months of cold weather when water is distributed by tank trucks. Such methods involved considerable handling of the water and enhance the possibilities of contamination.

Utilidors, although successfully operated in military and other government installations, do not appear to be economically feasible for less compact communities or residential areas in Alaska. Costs per linear foot of various types of concrete utilidors, based on United States prices, were estimated from $35.30 to $40.70 by Hyland and Mellish in 1948. Based on a cost factor of 3.0, which was valid in the Fairbanks and Nome areas in May, 1948, (but which has since increased), costs would range from $105.90 to $122.10 per linear foot, or from $5,295.00 to $6,105.00 for constructing such a system for a 50-foot lot. In addition to prohibitive cost, there are obvious health hazards involved in having sewer and water lines in the same enclosed system. That utilidors serve as an ideal nesting place for rats, permitting easy access to buildings, has also been pointed out.

Perhaps the most promising type of community system for the permafrost areas of Alaska is the dual main recirculating system which has been used successfully in Canada. This system involves heating the water at the source, pumping it through a high pressure main and back to the pump station through a low pressure main. This permits continuous recirculation through a house service connection by taking off from the high pressure main and returning to the low pressure main.

A laboratory study has been made on a single main recirculating system which indicates that such a system can be used successfully and recirculation maintained in the house service connection. It appears that velocities of 1 to 2 feet per second can be attained in the service connection, with velocities of 2 to 4 feet per second in the main. Tentative plans now provide for the construction of a limited main recirculating system for observation purposes in one of the projects to be financed by the Alaska Public Works.

Although simple chlorination is the only treatment provided in any civilian community water supply in Alaska, need for additional treatment is frequently apparent. In some instances the ground waters are quite hard, and high in iron content. Many of the surface waters carry relatively heavy loads of silt. Temperature is, of course, an important consideration in designing water treatment facilities in these areas. Due to increased viscosity at low temperatures, the waters are capable of carrying much greater loads of suspended material, and the efficiency of such treatment processes as coagulation, sedimentation, aeration and disinfection may be markedly affected. Considerable investigation in the treatment of Alaskan waters is indicated.

SEWAGE DISPOSAL

Of the 56 communities in Alaska with populations of 200 or more, only five have community sewage disposal facilities, all of which are in need of some improvements, replacements or extensions. Eight have partial community systems, supplemented by private facilities. Forty-three have no community sewage disposal facilities, relying entirely on private sewers, cesspools and privies.

Reading thermocouples to obtain ground temperature data on septic tank installations at University of Alaska.

To date, the design and construction of a workable and economically feasible sewage collection system has been a major problem in community sewage disposal in permafrost areas. Investigation of existing installations in Alaska and observations of systems in the permafrost area of Canada have led to the conclusion that most of the problems involved in community sewage collection systems can be solved by strict adherence to good engineering design practice, with minor modifications in conventional design and operating practices.

The operating problems of the community sewage collection system at Fairbanks is an example of what may be expected when standard design and construction practices are applied without due consideration given to extreme climatic conditions of Alaska. The cost of thawing operations on this system, serving a population of approximately 5,000, was $16,031.14 during the winter of 1947-48 and $35,033.93 during the winter of 1948-49. The higher cost for 1948-49 reflects an earlier freeze-up and increased costs for labor and materials.

Observations to date on the Fairbanks and other systems in Alaska have demonstrated the importance of providing adequate cover, adequate grades and a minimum flow. All three factors are controllable by good engineering, and apparently such control, within practical limits, would largely provide a trouble-free system in permafrost areas.

Other factors, such as the relative suitability of various types of pipe in relation to heat transmission and resistance to damage by freezing, effect of soil compactness, location of lines to take advantage of snow cover, loss of heat through manholes and house vents, and effect of turbulent flow on heat losses from sewage need investigation.

Utilidors have been used successfully but are expensive and involve sanitary hazards as noted in the discussion of water distribution systems.

At present, treatment of sewage does not constitute a critical problem in Alaska. As populations increase, however, the discharge of raw sewage to natural water courses will become a more significant health problem. Thus the need for investigation to provide a basis for design of treatment facilities suitable for low temperature operation becomes apparent. Primary treatment will probably be adequate in most of Alaska for some time because of relatively small concentrations of population and the availability of large bodies of water for final disposal. Therefore, applicability of primary treatment processes, including sedimentation and sludge digestion and disposal, should be given priority in the research program.

All common treatment processes seem adaptable to Arctic and sub-Arctic use. Optimum temperatures in accepted treatment processes are relatively high compared to temperatures at which sewage could be expected to reach treatment facilities in Arctic and sub-Arctic areas. The problem in these areas therefore resolves itself largely to one of economics, involving a comparison of the cost of adding and conserving heat with that of constructing larger treatment facilities to operate at lowered efficiency.

Rates of biochemical stabilization and bacterial die-away rates in Arctic streams may have considerable bearing on the degree of treatment necessary. Studies are needed to determine the effect of factors such as heavy ice cover during much of the year, heavy loads of silt and organic matter, heavy pollution loads due to thawing of winter accumulations during the spring breakups, and accumulation of dead salmon during the spawning season.

Single premise sewage disposal methods are of particular importance in Alaska since approximately 75 per cent of the 130,000 people in the Territory are still dependent on single premise methods. With some modifications, most of the common methods used in the temperate climates have been used in Alaska. However, their effectiveness and safety are sometimes impaired by the effects of low temperature on the chemical and biological processes and on the physical state of materials involved.

Thawing Frozen Sewer Lines at Fairbanks, Alaska.

Although esthetics, economics and physical comfort, as well as public health, are important in single premise disposal methods, the greatest problem appears to be that of satisfactory final disposal. The usual methods of subsurface disposal, including conventional disposal fields, seepage pits or cesspools, are not generally suitable in areas underlain with permafrost, especially if the active layer is relatively thin. Adequate leaching action cannot be obtained, and the entire system may freeze during the winter. The formation of frost mounds, a result of freezing of entrapped water, may be one unfortunate result when subsurface disposal of liquid wastes is attempted. This, in many cases, precludes the use of a conventional water carriage system.

Pit and surface privies are not satisfactory in permafrost areas. Leaching action does not occur because of the frozen ground. During the summer the pits may be filled with water, while in the winter all deposits remain frozen. In addition to the sanitation hazards involved, lack of heat and the resulting physical discomfort makes the use of privies impractical.

Because of lower cost as well as the practical problems involved, the box and can system or modifications thereof is, at present, the most common method of sewage disposal for single dwellings in the Alaskan Arctic. Although not desirable from the esthetic standpoint, it is probably the most practical system for isolated single dwellings and small villages in the permafrost area.

According to custom, a can or other receptacle is generally used within the dwelling and later dumped on nearby ground surface outside, producing disagreeable and unhealthy conditions during the spring thaw. In some small communities, the receptacles are emptied into barrels or other containers and later hauled to a point outside the community and dumped on the ground surface. Frequently the distance from the community is not sufficient to eliminate either the nuisance or the health hazard. In coastal communities the filled containers are placed on the river or sea ice during the winter to be carried away in the spring.

In larger communities where the box and can system is used, scavenger services are usually provided either by the municipality or by private operators. Frequency of collection varies from twice weekly to weekly or even to longer intervals. Collection fees vary with the frequency of collection. After collection, the excreta is hauled to a relatively isolated spot outside the community and dumped. In coastal areas it is sometimes left on the beaches for tidal removal. In one instance where this method was observed, excreta was dumped at a point at least 10 feet above high tide.

Chemical toilets are not extensively used in Alaska. Their use, as a modification of the box and can system, would do much to eliminate the health hazard if not the nuisances which result from unsatisfactory disposal methods.

WASTE DISPOSAL

To date, industrial wastes do not constitute a major public health problem in Alaska. There are approximately 160 fish canneries operating seasonally in the Territory. They presently constitute the major industrial waste problem. Generally the wastes are deposited on the beaches or tide flats near the plants for removal by tide action. Most of the canneries are located in relatively isolated areas and, almost without exception, large volumes of water are available for dilution. Some local nuisances do occur.

The development of the pulp industry in Southeastern Alaska potentially presents the greatest industrial waste problem. Construction of the first of several proposed mills is scheduled to begin in the spring near Ketchikan. At present the greatest significance of this development appears to be its possible effect on fish life in the area. Baseline surveys to determine the physical, chemical and biological characteristics of the proposed receiving waters are now in progress. This work is being done on a cooperative basis by the Alaska Department of Health, U. S. Fish and Wildlife Service, U. S. Forestry and the U. S. Public Health Services.

Basic studies are also being planned to determine the extent of stream damage resulting from gold dredging operations in the Fairbanks area and the rates of recovery of Arctic and sub-Arctic streams.

An adequate legal basis for control of receiving waters is provided by the Alaska Water Pollution Control Act adopted by the Territorial Legislature in 1949. However, adequate funds for investigation and a control program have not been made available.

Garbage disposal is generally unsatisfactory throughout the Territory. The usual method is by dumping and burning. Along the coast garbage is often dumped on beaches to be carried away by tide action. In areas of Alaska free of permafrost, the garbage disposal problem is not significantly different from that in the colder areas of the United States. In the permafrost areas incineration appears the most feasible method. However, the cost of this method would be relatively high because of the small quantity of combustible material. Grinding and disposal with sewage could be the solution in larger cities.

HOUSING

The extremely high cost of labor and materials, among other factors, has led to the construction of much sub-standard housing in Alaska. Houses are kept small for economy in heating as well as to keep construction costs down. Inadequate housing results in crowded and unsanitary conditions, which undoubtedly play a role in the high incidence of tuberculosis, pneumonia and influenza.

The growth and development of Alaska has been rapid and continuous during the past ten years, with boom conditions in the areas adjacent to military establishments, primarily near Anchorage and Fairbanks. The increased need for housing in Southeastern Alaska, the Kenai Peninsula and the Bristol Bay to Norton Sound areas has been gradual and has at no time equalled that of the Anchorage and Fairbanks areas.

Housing needs in several communities were estimated by the Alaska Housing Authority in 1949 as follows:

City	*Units Needed*
Ketchikan	300
Juneau	500
Anchorage	3,000
Fairbanks	1,000

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Although many units have been constructed, the demand has continued to grow and is probably as great now as in 1949.

Along the Bering Sea coastline, as well as in the river areas, there is an acute need for financial aid to the natives for repair and improvement of their homes. Some work of this nature is being carried out by the Alaska Housing Authority which makes $500.00 character loans to the natives for construction of 14′ x 20′ frame cabins. The cabins are little more than shelters but at least they bring the natives up out of their sod huts. It is estimated that the Alaska Housing Authority will be able to assist 1,000 to 1,500 native families in another 2 to 3 years. Economic inability to construct and maintain standard modern homes in this area make demands for this type of housing rare.

In the Anchorage and Fairbanks areas, it is estimated that 75 per cent of private homes are built or enlarged by the owner or by other unskilled labor. Until the economic picture changes, the percentage of self-built homes is certain to remain at a high level. It is felt, therefore, that considerable improvement in housing could be achieved by the provision of guide material for the amateur builder. Such guides are being developed under terms of a contract awarded to the University of Minnesota by the Housing and Home Finance Agency of the Division of Housing Research.

Studies should also be initiated to determine the suitability and the possibilities of developing and using native materials.

INSECT CONTROL

Although there is no known disease transmission by biting insects in Alaska, their nuisance value is high and control in some areas is desirable if not essential. This is particularly true around military establishments and civilian communities.

Primarily due to extensive breeding areas and long flight ranges, mosquito control by drainage or by application of larvicides does not appear to be feasible. Airplane spraying has been used over large areas but the necessary frequency and extent of application makes this a costly procedure.

The Entomology Branch of the Arctic Health Research Center has developed aerosol spray equipment to provide control for small areas. The equipment consists essentially of a series of dispensers placed upwind from the area to be treated. The dispensers are operated by compressed air. Refinement of airplane spraying methods is now being attempted. Efforts are directed to developing equipment to break up a larger percentage of the spray solution to droplet sizes ranging from 2 to 40 microns in diameter. It is expected that this will make possible a reduction in the rate of application per acre, increase the width of swath that can be covered, and permit use of small planes.

Further studies of the biology of the biting insects (mosquitoes, punkies, snipe flies and black flies) is necessary for formulation of control programs and development of equipment.

The military significance and natural resources of Alaska assure its future development. Provision of a healthful environment—good housing, safe and adequate water supplies, and safe methods of waste disposal will play a significant part in this development. A comprehensive and systematic program of investigation can result in the saving of many thousands of dollars in providing such a safe environment.

Substandard Housing near Anchorage, Alaska.